Small Business Innovation Research/Small Business Tech Transfer

Field Programmable Short Wave Infrared Photodetectors, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

We propose to advance the state-of-the-art in short wave infrared (SWIR) detectors to meet NASA's needs for advancements in communications technology. Antimonide-based Type II Superlattice (T2SL) infrared (IR) detectors have made significant advances in the past decade. The interest in this technology stems from (1) the ability to tailor the T2SL bandgaps across the IR region and (2) the manufacturability of T2SL structures using III-V foundries and horizontal integration schemes. NASA researchers have been involved with efforts to develop T2SL IR detectors for a variety of space-related missions, both in communications and sensing. We propose to complete a fundamental feasibility study leading to a prototype of a single pixel, field programmable, SWIR photodetector. This detector will use antimonide-based T2SL materials as the absorber. This detector will operate at relative high temperature (above 250 K). Most uniquely, this detector's voltage bias can be programmed to operate with either high dynamic range or high sensitivity. High dynamic range uses a low voltage bias (<1 V) and operates the detector in a standard PIN configuration. High sensitivity uses a high voltage bias (20 to 30 V) and operates in the linear amplification region of an avalanche photodiode (APD). The detector is engineered for high signal-to-noise operation in both modes. The user or the control software can adaptively trade off dynamic range versus sensitivity on the fly and in response to measured characteristics of the scene (for example, photon flux or noise conditions). This detector will work ideally with an emerging generation of readout integrated circuits that will control the voltage of pixels selectively, leading to a focal plane array (FPA) that can algorithmically decide the operational mode of each pixel. Because the band structure of T2SL materials is designed, we will be able to engineer a detector that meets all of these targets simultaneously.

Anticipated Benefits

The proposed detectors will address:

Free space, satellite-based optical communication with a high operating temperature, high speed photodetector.

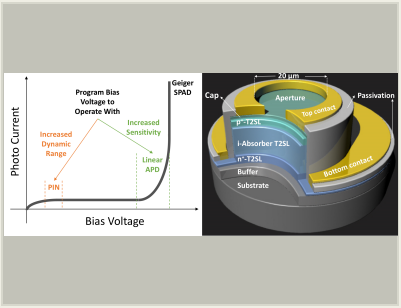
An imaging array for beaconless pointing as part of the Integrated RF and Optical Communication (iROC) development effort at NASA.

High operating temperature, high sensitivity detector for quantum key distribution (QKD), as one example of quantum communications.

Dynamic imaging array for short-wave lidar and atmospheric gas monitoring.

The proposed detectors will address:

Enhanced lidar and imaging navigation.



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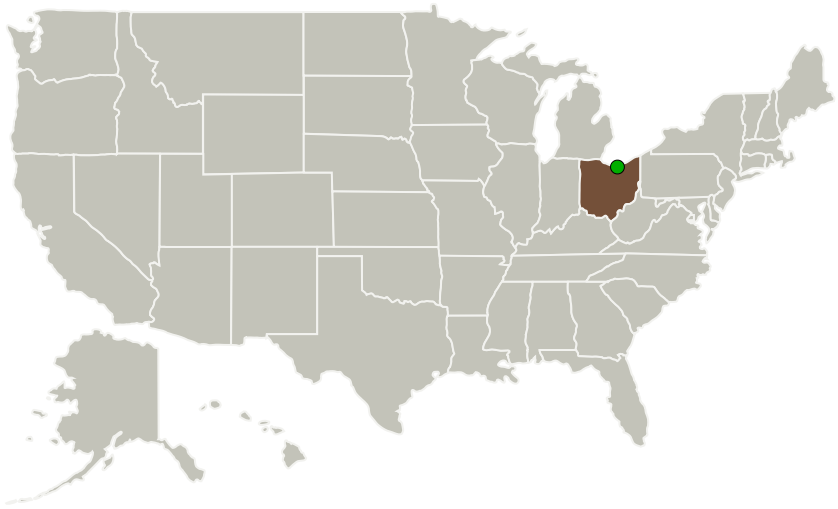
Reconfigurable and combined systems for navigation and optical communication. We expect that reconfigurable detectors for satellite systems will follow the path set by reconfigurable computing over the past two decades.

High operating temperature, high sensitivity detector for quantum key distribution (QKD), as one example of quantum communications.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
SK Infrared, LLC	Lead Organization	Industry Small Disadvantaged Business (SDB)	Columbus, Ohio
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations
Ohio

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

SK Infrared, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

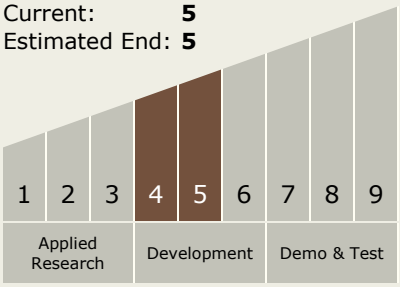
Carlos Torrez

Principal Investigator:

Earl Fuller

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**



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Project Transitions

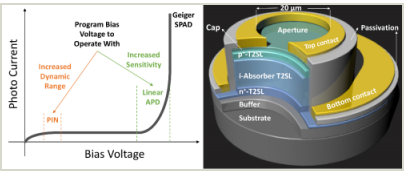
July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141054)*

Images



Briefing Chart Image
Field Programmable Short Wave Infrared Photodetectors, Phase I *(https://techport.nasa.gov/image/125817)*

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.5 Revolutionary Communications Technologies
    - TX05.5.2 Quantum Communications

Target Destination

Earth